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# THE PERFORMANCE OF ANGORA RABBIT DOES AND THEIR PROGENY DEPENDING ON THE SEMEN USED FOR AI

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**SUMMARY** - German Angora does were inseminated with either Pannon White (N) or heterospermic (N+A) or Angora (A) rabbit semen to compare the reproduction and growth traits of 54 NxA, 53 (N+A)xA and 65 AxA matings. The kindling rate was 59.3, 58.5 and 47.7%, resp., the value of total born per litter averaged 7.09, 6.36 and 6.19, litter size at 21 days of age 5.73, 5.97 and 4.89, and litter weight at 21 days 1739, 1700 and 1446 g. In the (N+A)xA group the ratio of NA and AA offspring at 21 days of age was 70.1% and 29.9%, which differed from the expected 1:1 distribution (P<0.05). Rabbits were weaned at 42 days of age. For 91 NA from NxA, 74 NA and 30 AA from (N+A)xA, and 94 AA offspring from AxA mating combinations, the body weight averaged 317, 287, 288 and 303 g at 21 days and 1054, 993, 869 and 908 g at 42 days, and 2004, 1891, 1610 and 1594 g at 70 days, and the daily weight gain between 3 and 6 weeks of age was 35.0, 33.6, 27.7 and 28.8 g and between 6 and 10 weeks of age 33.4, 32.1, 25.4 and 24.7 g, resp. It was concluded that the Angora semen disadvantageously influenced the fertility and litter size. The larger birth litter size, better gain and lower mortality of NA and their higher ratio in the heterospermic group showed their better viability compared to AA rabbits. The body weight of NA born in the heterospermic group differed more and more with advancing age from their AA littermates, which supports the hypotheses of the negative pleiotropic effect of the Angora gene and/or the remaining part of the genome on growth.

**Key words**: Rabbit, Pannon White, Angora, crossing, reproduction, growth

***RESUME*** - Des lapines angora de souche allemande ont été inséminée avec de la semence de lapin à pelage commun de souche Pannon Blanc (N), à pelage angora (A) ou d'un mélange hétérospermique (N+A) afin de comparer les performances de reproduction et de croissance de 54 NxA, 53 (N+A)xA et 65 AxA accouplements. Les taux de mise bas ont été de 59,3, 58,5 et 47,7%, le nombre total de lapereaux nés de 7,09, 6,36 et 6,19, la taille de portée à 21 jours 5,73, 5,97 et 4,89, et le poids de portée à 21 jours 1739, 1700 et 1446 g respectivement. Dans le groupe (N+A)xA, la proportion d'individus NA et AA à 21 jours a été respectivement de 70.1% et 29.9% ce qui est significativement différent du ratio 1:1 attendu a priori (p<0,05). Les lapereaux ont été sevrés à l'âge de 42 jours. Chez les 91 animaux NA issus des inséminations NxA, les 74 NA et 30 AA issus de (N+A)xA, et 94 AA issus de AxA, le poids vif moyen a été respectivement de 317, 287, 288 et 303 g à 21 jours, 1054, 993, 869 et 908 g à 42 jours, et 2004, 1891, 1610 et 1594 g à 70 jours, avec un gain moyen quotidien de 35,0, 33,6, 27,7 et 28,8 g entre 3 et 6 semaines d'âge et de 33,4, 32,1, 25,4 et 24,7 g entre 6 et 10 semaines d'âge. En conclusion il apparaît que la semence de lapin angora a une influence négative sur la fertilité et la taille de portée. Comparativement aux animaux AA, les résultats ont montré qu'en raison d'une plus grande taille de portée à la naissance, une plus faible mortalité, un meilleur gain de poids et une plus forte proportion dans le groupe hétérospermique, les lapereaux NA ont une meilleure viabilité. Dans le groupe hétérospermique, la différence de poids entre les animaux NA et AA s'est accru avec l'âge en faveur des lapereaux NA, ce qui soutient l'hypothèse d'un effet pléïtropique négatif du gène angora et/ou de la partie résiduelle du génome angora sur la croissance.

***Mots-clés:*** Lapin, Pannon Blanc, Angora, croisement, reproduction, croissance

## INTRODUCTION

Heat stress caused by the fur (Brockhausen et al.,1979; Schlolaut, 1987 and 1994; Thébault and Allain, 1994), the pleiotropic effect of the Angora gene (Damme *et al.*, 1985; Gupta *et al.*, 1995; Bolet *et al.*, 1996) and/or the remaining part of the genome (Rochambeau, 1988), the targeted selection for wool production (Rochambeau, 1988; Schlolaut, 1988) and the effect of close inbreeding (Schlolaut, 1974; Gupta *et al.*, 1995) can be the reason for the poorer performance of Angora rabbits. Prolificacy improves by crossbreeding the Angora flocks (García *et al.*,1984; Shen *et al.*, 1992; Wang and Jiang, 1992; Wang and Zheng, 1993). Shen *et al.* (1992) described an improvement in the maternal traits by crossing normal hair and Angora rabbits. Oláh (1958) observed an intermedier growth of the F1 progeny by doing a reciprocal mating of the two breeds. In the experiment by Damme *et al.* (1985) backcrossing the F1 does with Angora bucks, the 90-day weight of the heterozygous and the Angora progeny differed by 6%, which allowed the authors to conclude to the negative pleiotropic effect of the Angora gene on growth.

In our research Angora does were inseminated with normal hair Pannon-White (N), Angora (A) and heterospermic (N+A) semen to compare the maternal traits. In the heterospermic group we compared the real genotypic ratio of the progeny to the expected distribution of 1 to 1, and we tried to find out if there was any difference in the growth between the NA and AA progeny and the matingly different but genetically identical heterozygous (NA) and Angora (AA) rabbits.

## MATERIAL AND METHODS

Multiparous German Angora (A) does (n=77) were artificially inseminated (AI) in five mating periods between May and September on the Experimental Rabbits Farm of the Pannon Agricultural University. The **breeding does** were kept in flat-deck wire cages (80x50x40 cm) individually, in a room fitted with windows. Supplementary neon lights were also applied. The room was heated with blown-in warm air (15 to 16 °C) in winter. In summer the temperature became more elevated and reached 25 °C temporarily. Nest boxes were hung on the outside of the cages 3 days before littering. These boxes were removed at 21 days of age of the young. The doe was taken out of the cage at weaning. The **offspring** stayed in the cage together (5 to 6 rabbits/cage) for another 12 weeks. The does and their progeny were fed the same pelleted, commercial **diet** *ad libitum* (86% dry matter, 16.5% crude protein, 2.70% crude fat, 15.5% crude fibre, 0.70% lysine, 0.32% methionine, 0.60% methionine+cystine, 10.3 MJ/kg DE, 3 mm pellet diameter). The rabbits had free access to the valved self-drinker. No supplementary hay was provided.

The does were **inseminated** on the 25th to 30th day *post partum*. Those that remained not pregnant (pregnancy check 10 to 14 days after insemination) were re-inseminated 28 to 30 days after the previous AI. Every doe was expected to deliver three times. The quality of the semen was checked macroscopically and microscopically (for density and motility) and scored from 0 to 5 (5 was the best). The fresh semen was diluted in a ratio of 1:5-8. The heterospermic inseminations were carried out with a mixture of semen (1:1) of similar quality of the N and A bucks (n=10-10). At AI, a dose of 1.5 µg of GnRH analogue hormone (Ovurelin, manufactured by Reanal, Hungary) was administered to induce ovulation. Litter size at birth were standardized to 6 by using fostering within a group. The does were allowed to nurse any time. The 21 days old rabbits were sexed, weighed and tattooed individually. They were weaned at 42 days of age. The does, which remained not pregnant three times, and those, which were culled or died before they produced a litter were excluded from the experiment, and their data were eliminated from the evaluation (n=10).

**The experimental groups**

| Sire x Dam | Symbol of Mating | Genotype of Progeny |
|---|---|---|
| Pannon White x German Angora | NxA | NA |
| Heterospermic x German Angora | (N+A)xA | NA/AA |
| German Angora x German Angora | A x A | AA |

The three groups of the Angora does were inseminated with N, A or heterospermic (N+A) semen in a sequence. This way, the same doe could act up in every group. With this design our intention was to reduce the standard error caused by grouping small number of does. The does, which returned were re-inseminated with the type of semen used previously. The genotype of the offspring in the (N+A)xA group was determined based on the fur at 3 weeks of age.

The **statistical evaluation** was carried out according to the GLM procedure using the programme package of SAS ver. 6.09. The factors affecting the single traits were tested by analysis of variance based on the individual data, taking the fixed effects into account (i.e. paternal genotype, parity, sex, number of does` teats, season) by using the following model:

$Y_{ijklmno}$= $\mu+Gp_i+P_j+Go_k+S_l+T_m+Se_n+e_{ijklmno}$

in which

| | |
|---|---|
| $Y_{ijklmno}$ | the performance |
| $\mu$ | overall mean |
| $Gp_i$ | effect of paternal genotype (i=1,2,3) |
| $P_j$ | parity effect (j=1,2,3,4,5) |
| $Go_k$ | genotype of the offspring (k=1,2) |
| $S_l$ | sex effect (l=1,2) |
| $T_m$ | effect of the doe`s number of teats (m=1,2,3) |
| $Se_n$ | season effect (n=1,2,3) |
| $e_{ijklmno}$ | standard error |

The analysis of significance of the distributions was performed by Chi-square Test (FREQ-Test, SAS ver. 6.09).

## RESULTS AND DISCUSSION

The N **bucks** produced better quality semen then the Angoras (2.03 and 2.57, P<0.001). This finding is in accordance with the observations by Hu *et al.* (1988), Radnai *et al.* (1988) and Theau Clément *et al.* (1991). Season did not affect the semen quality (P>0.05).

In the groups the Angora **does** weighed the same, i.e. 3437±32 g at insemination and 3400±44 g after littering. At AI the does were 4.5% smaller in spring and by 6.4% in summer than in autumn (P<0.01). The non pregnat does were 3.5% lighter at insemination than those that delivered later (3377 g and 3497 g, P<0.05), which means that poorer body condition resulted in weaker fertility.

**Conception rate** was the highest in the group of does inseminated with N semen. Performance of the (N+A)xA group is lower but close similar to NxA group. Kindling rate was lowest in the AxA matings (*Table 1*). Although the differences are not significant, it is still clear that the semen of Angora bucks reduced the kindling rate because of its poorer quality and lower fertility. Our results coincide with those reported by Sinkovics *et al.* (1983) and Brockhausen *et al.* (1979) concerning the conception characteristics of German Angora rabbits (45% and 46%).

**Litter size** at birth proved by 0.82 larger in the NxA group as compared to the other two types of mating. The number of offspring born alive was by 0.3 larger in the group of does inseminated with heterospermic semen than in the AxA group (*Table 1*). This phenomenon goes back to the better fertility of N semen, and also, to the improved viability of the heterozygous embryos and foetuses in the uterus. In terms of the number of progeny (total and born alive) of German Angora rabbits, Schlolaut (1987) reported similar (6.18 and 5.43), García *et al.* (1984) smaller (3.92 and 3.33), while Shen (1992) bigger values (7.61 and 7.17) than ours. Litter size at 3 and 6 weeks of age was smaller by 1 in the AxA group than the average in the NxA and (N+A)xA matings. These differences are non-significant though, but support the opinion that crossbred litters are more populous (Blasco *et al.*, 1993). Evaluating New Zealand White x Angora litters as compared to purebred Angoras Shen (1992) found larger litters (the difference was almost 1 rabbit) in favour of the crossbreds (7.61 vs. 8.33 at birth and 5.70 and 6.33 at weaning), too. In spite of the better growth rate and heavier weight of the NA progeny, the Angora does could not raise more rabbits in the NxA litters than in the (NxA)+A group (*Tables 1 and 2*). Thus our findings support the opinion that Angora does are unable to raise litters larger than 6 rabbits (Rougeot and Thébault, 1989; Hullár and Szabó, 1991).

**Ratio of the NA and AA progeny in the (NxA)+A group** was found to be 70.1% and 29.9%, respectively (P<0.001), i.e. the number of Angora offspring was significantly fewer than it was expectable theoretically (50% to 50%). In addition to the kindling rate, this result underlines that the Angora semen is less fertile, and proves that the NA offspring show better prenatal vitality than the AA ones.

Total litter losses until 21 days of age (20.7%, 20.7% and 14.3%) and **mortality** of the suckling rabbits (17.6%, 9.04% and 16.7%) were similar in the NxA, (N+A)xA and AxA groups, respectively

(P>0.05). There was no difference in the rate of mortality even in the period between 3 and 6 weeks of age (6.4%, 4.0% and 5.8%). Gupta *et al.* (1995) could wean 3.62 out of 5.68 rabbits born in Russian Angora rabbits. Similarly to our results, they detected higher mortality during the first few weeks of life.

Although the difference was non-significant, 21-day **litter weight** was smaller in the AxA group than in the NxA and (N+A)xA matings, which can be explained by smaller litter size (*Table 1*).

In the most populous litters of (N+A)xA group the **individual weight** of the 21 days old littermate NA and AA offspring did not differ at all (*Table 2*), which indicates that the doe's milk production determines the growth of the progeny during the lactation period. Thereafter the NA rabbits grew significantly faster (p<0.05) than their AA littermates. Moreover, at 12 weeks of age they made up for their lag behind the NA rabbits born from NxA mating. Body weight of the crossbred NA progeny of the same doe proved heavier than that of their AA littermates by 14.3%, 17.5% and 20.1% at 6, 10 and 12 weeks of age, respectively (P<0.001). This finding supports the statements by other authors concerning the negative pleiotropic effect of the Angora gene (Damme *et al.*, 1985; Gupta *et al.*, 1995) and/or the negative effect of the remaining part of the genome of the Angora rabbits (Rochambeau, 1988) on growth. Shen *et al.* (1992) reported 15.6% difference in body weight at 6 weeks of age in favour of New Zealand White x Angora crossbreds as compared to the purebred Angoras, which is very similar to our difference of 14.1% observed between the NxA and AxA progeny.

**Mortality loss** was bigger in the progeny of the AxA group than in that of the NxA group during the interval from weaning to 10 weeks of age (8.1% vs. 2.0%, P<0.05, resp.). This value fell between the previous extremes in the (N+A)xA group (4.0%). Within this group the NA and AA littermates showed the same rates of mortality. Mortality differences among the experimental groups were not significant any more between the ages of 10 to 12 weeks (1.5%, 2.3% and 4.0%), nevertheless, the biggest loss was detected in the AxA group again.

Conception rate was poorer **in summer** (44.4%, P<0.05) than in spring (57.5%) or autumn (74.1%), and litter size at birth seemed also smaller by 0.63 (P>0.05). Reduced litter size in summer (Simplicio *et al.*, 1988) is caused by the higher occurrence of semen abnormalities (Hu *et al.*, 1988; Theau-Clément *et al.*, 1991) and the higher rate of embryonic mortality (Ashour *et al.*, 1995) at that time of the year. In our investigation the litter sizes at 3 and 6 weeks of age were the same in spring and in autumn but they were smaller in summer (-8.4% and -17%, P<0.05). Body weight and weight gain of the progeny were biggest in winter, medium in autumn but remarkably reduced in summer (by 8.2-10.7% and by 5.1-15.7%, resp.,P<0.001). These seasonal changes correspond with those reported by Wang and Zheng (1993) and Gupta *et al.* (1995). Heat stress, namely, influences the feed intake (Ayyat and Marai, 1996) and weight gain (Lukefahr *et al.*, 1996) of the rabbits in a negative way. In hot weather the does lose weight and produce less milk (Fernandez-Carmona *et al.*, 1994; Papp, 1997). Because of the heat shock caused by the long wool cover these adverse effects may be more expressed in the case of the Angora rabbits.

## CONCLUSIONS

The poorer quality of the semen of Angora bucks resulted in lower conception rate and smaller litter size. We detected 70% of NA and 30% of AA genotype in the 3 weeks old progeny born from the (N+A)xA matings. This finding was different from the theoretically expectable 1:1 ratio and could be explained partly by the poorer quality of Angora semen and partly to the higher intrauterine survival rate of the crossbred progeny.

The litter mates of NA and AA genotype born from heterospermic inseminations weighed the same at 3 weeks of age. Later on, the NA rabbits grew significantly better, which gives evidence of the pleiotropic effect of the Angora gene and/or the unfavourable effect of the remaining part of the genome on growth.

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**Table 1 Comparison of kindling rate, litter size and 21 d litter weight of German Angora rabbit does inseminated with N, A or heterospermic (N+A) semen**

| Trait | Kindling rate | Litter size | | | | | | | | | | | | | 21 d litter weight | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total | | | Alive | | | Nursed | | 21 days | | At weaning | | | g | |
| | % | n | LSM | SD | n | LSM | SD | n | LSM | SD | LSM | SD | LSM | SD | n | LSM | SD |
| Overall mean | 54.7 | 86 | 6.55 | - | 83 | 6.08 | - | 80 | 6.20 | - | 5.53 | - | 5.22 | - | 58 | 1628 | - |
| Group[1] | | | | | | | | | | | | | | | | | |
| NxA | 59.3 | 28 | 7.09 | 2.17 | 27 | 6.76 | 1.92 | 26 | 6.61 | 1.93 | 5.73 | 1.49 | 5.44 | 1.42 | 18 | 1739 | 416 |
| (N+A)xA | 58.5 | 29 | 6.36 | 2.85 | 27 | 5.90 | 2.87 | 27 | 6.08 | 2.18 | 5.97 | 2.00 | 5.66 | 2.09 | 19 | 1700 | 606 |
| AxA | 47.7 | 29 | 6.19 | 3.11 | 29 | 5.59 | 2.77 | 27 | 5.92 | 2.21 | 4.89 | 2.15 | 4.55 | 2.17 | 21 | 1446 | 515 |
| Group effect | NS | | NS | | | NS | | | - | | NS | | NS | | | NS | |
| Parity effect | * | | NS | | | NS | | | - | | NS | | NS | | | * | |
| Season effect | * | | NS | | | NS | | | - | | * | | * | | | * | |

[1] group: sire x dam

**Table 2 Comparison of the body weight and daily weight gain of normal hair (NA) offspring born from NxA or (N+A)xA matings and Angora progeny (AA) deriving from groups of (N+A)xA or AxA**

| Trait | | Individual weight, g | | | | | | | | | | | | Daily weight gain, g/day | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | | | 3 weeks | | | 6 weeks | | | 10 weeks | | | 12 weeks | | 3-6. wk | | 6-10. wk | | 10-12. wk | |
| | | n | LSM | SD | n | LSM | SD | n | LSM | SD | n | LSM | SD | LSM | SD | LSM | SD | LSM | SD |
| Overall mean | | 289 | 299 | - | 278 | 956 | - | 249 | 1775 | - | 230 | 2158 | - | 31.3 | - | 28.9 | - | 28.8 | - |
| Group[1] | Progeny | | | | | | | | | | | | | | | | | | |
| NxA | NA | 91 | 317$^{a}$ | 82 | 87 | 1054$^{a}$ | 193 | 80 | 2004$^{a}$ | 280 | 69 | 2393$^{a}$ | 305 | 35.0$^{a}$ | 6.2 | 33.4$^{a}$ | 7.3 | 31.7$^{a}$ | 10 |
| (N+A)xA | NA | 74 | 287$^{b}$ | 45 | 69 | 993$^{b}$ | 137 | 64 | 1891$^{b}$ | 263 | 62 | 2347$^{a}$ | 273 | 33.6$^{a}$ | 5.3 | 32.1$^{a}$ | 7.0 | 32.4$^{a}$ | 8.8 |
| (N+A)xA | AA | 30 | 288$^{b}$ | 52 | 30 | 869$^{c}$ | 114 | 26 | 1610$^{c}$ | 266 | 27 | 1941$^{b}$ | 328 | 27.7$^{b}$ | 4.9 | 25.4$^{b}$ | 7.8 | 25.1$^{b}$ | 12 |
| AxA | AA | 94 | 303$^{ab}$ | 71 | 92 | 908$^{c}$ | 152 | 79 | 1594$^{c}$ | 253 | 72 | 1950$^{b}$ | 310 | 28.8$^{b}$ | 5.0 | 24.7$^{b}$ | 5.8 | 25.9$^{b}$ | 8.1 |
| Group effect | | | * | | | *** | | | *** | | | *** | | *** | | *** | | *** | |
| Parity effect | | | *** | | | *** | | | *** | | | *** | | *** | | *** | | NS | |
| Sex effect | | | NS | | | NS | | | NS | | | NS | | NS | | NS | | NS | |
| Doe`s teat | | | NS | | | * | | | - | | | - | | NS | | - | | - | |
| Season effect | | | *** | | | *** | | | *** | | | *** | | * | | *** | | NS | |

[1] group: sire x dam

NS: P>0.05 *P<0.05 **P<0.01 ***P<0.001